CLAIMS:

1. A method of cleaning a fouled RO membrane in a module for RO separation, said membrane having a feed side and an opposite permeate side and extending between a front end and a rear end of said module, said module having a front-end feed port and a rear-end brine port in communication with said feed side of the membrane, and at least one permeate port in communication with said permeate side of the membrane, a normal RO separation process in the same module including feeding raw saline solution, which comprises solvent, dissolved salts and a potential foulant, with osmotic pressure PO1, to said front-end feed port at gauge pressure PF1 > PO1, collecting weak saline solution called permeate from said permeate port at gauge pressure PP2, and removing residual brine from said rear-end brine port at gauge pressure PB3 > PO1, the foulant accumulating at the feed side of the RO membrane, said cleaning method comprising

a) feeding dilute saline solution to the permeate side of the RO membrane under gauge pressure PD4 and osmotic pressure PO4;

b) feeding concentrated saline solution to the feed side of the RO membrane under gauge pressure PC5 and osmotic pressure PO5, a net driving differential ΔPN resulting from pressures PO4, PD4, PO5, and PC5 being directed to the feed side, whereby the solvent is being sucked from the permeate side of the RO membrane to the feed side of the RO membrane, penetrates into the interface between the membrane and the accumulated foulant, and separates the foulant from the membrane surface; and

c) withdrawing the concentrated saline solution together with the separated foulant and the penetrated solvent from the feed side of the RO membrane,

wherein

said gauge pressure PC5 is between said pressures PF1 and PO1 in the normal RO process, while said ΔPN directed to the feed side is provided by raising said gauge pressure PD4 with respect to said gauge pressure PP2 in the normal RO process.

2. The method of Claim 1, wherein said concentrated saline solution of step (b) is residual brine supplied from another RO module performing normal RO separation process, or is said raw saline solution.

3. The method of Claim 1, wherein said dilute saline solution of step (a) is the permeate obtained in the same RO module during its normal separation process and stored, or is permeate obtained from another RO module performing normal RO separation process.

4. The method of Claim 3, wherein said concentrated saline solution of step (b) is said raw saline solution and said gauge pressure PD4 is equal to said gauge pressure PC5.

5. The method of Claim 4, wherein said raw saline solution and said permeate are fed to the respective side of the membrane by the same pressure source that provides the gauge pressure PF1 of the normal RO process.

6. The method of Claim 1, wherein said RO module is a first-stage module in a multi-stage desalination plant and said dilute saline solution of step (a) is residual brine obtained in a next-stage separator of the same desalination plant.

7. The method of Claim 1, wherein said permeate side of the RO membrane communicates with said permeate port through a permeate channel, said RO membrane having parts near said permeate channel and parts remote therefrom, and said net driving differential ΔPN is such that it allows said dilute saline solution to reach said remote parts of the RO membrane before said solvent is entirely sucked to the feed side of the membrane through said near parts thereof.

8. The method of Claim 1, wherein said concentrated saline solution is fed to said rear-end brine port at step (b), and is withdrawn from said front-end feed port at step (c).

9. The method of Claim 1, wherein said concentrated saline solution is fed to said front-end feed port at step (b), and is withdrawn from said rear-end brine port at step (c).

10. The method of Claim 1, wherein the feeding at step (b) and the withdrawing at step (c) of the concentrated saline solution are from time to time alternated between said front-end feed port and said rear-end brine port.

11. The method of Claim 1, wherein said gauge pressure PD4 is pulsating.

12. The method of Claim 1, wherein at least one of said gauge pressures PD4 and PC5 is from time to time changed so that said net pressure differential ΔPN is reversed towards the permeate side, whereby the RO module performs, in said time to time, normal RO separation process.

13. The method of Claim 1, wherein said RO module has a front-end permeate port and a rear-end permeate port in communication with said permeate side of the RO membrane, the feeding in said steps (a) and (b) being performed through the same-end port of the respective side, the method further comprising:

a') feeding a second dilute saline solution to the other-end permeate port under gauge pressure PD4 and osmotic pressure $PO4' < PO4$, said pressure PO4' compensating for a fall of the net driving differential ΔPN due to a fall of osmotic pressure at the feed side as the concentrated saline solution flows from said same-end feed port towards said other-end feed port.

14. The method of Claim 1, including adding a cleaning agent to the dilute saline solution of step (a) and/or to the concentrated saline solution of step (b).

15. The method of Claim 1, including

d) feeding the concentrated saline solution obtained in step (c) to an energy recovery plant.

16. The method of Claim 15, wherein said RO module is one of a plurality of RO modules, the rest of said plurality of RO modules performing normal RO separation process, said concentrated saline solution of step (b) is a portion of the residual brine removed from said rest of RO modules, and the method is applied in turn to each RO module of said plurality.

17. The method of Claim 16, wherein at least a portion of the removed residual brine from said rest of RO modules is fed to said energy recovery plant at pressure

PR, and the step (d) includes boosting the pressure of the concentrated saline solution withdrawn at step (c) up to said pressure PR.

18. A system for cleaning fouled RO membranes according to the method of Claim 1 in a desalination plant comprising a plurality of modules for RO separation with said RO membranes connected in parallel and adapted to perform the normal separation process of Claim 1, the desalination plant further comprising a source of said raw solution with high-pressure feed pump; a common high-pressure raw solution feed line connecting the front-end feed ports of the modules to said source of raw solution; a common high-pressure brine collection line connecting the rear-end brine ports of the modules to a first brine discharge outlet; a common permeate collection line connecting the permeate ports of the modules to a product storage tank or a next-stage separator,

said system comprising:

a) a pressurized source of said dilute saline solution providing said pressure PD4;

b) a common high-pressure cleaning line connecting the permeate ports of said modules to said pressurized source of dilute saline solution;

c) a pressurized source of said concentrated saline solution providing said pressure PC5;

d) a first line to connect said source of concentrated saline solution to said feed side of the membrane in each RO module;

e) a second line to withdraw said concentrated saline solution from said feed side of the membrane in each RO module; and

f) a plurality of valves adapted to close or open each of the above ports and common lines so as to allow performing of said normal separation process and said method of Claim 1 on each RO module in turn;

19. The cleaning system of Claim 18, wherein said first line is said common high-pressure brine collection line, said second line is a common line connecting front-end feed ports of said RO modules to a second brine discharge outlet, and said system is adapted to use a portion of the collected brine as concentrated saline

solution in the step (b) of the method, and to discharge said portion of brine through said second brine discharge outlet in step (c) of the method.

20. The cleaning system of Claim 18, wherein said first line is said common high-pressure raw solution feed line, said second line is said common high-pressure brine collection line, and said system is adapted to use a portion of the raw solution as concentrated saline solution in the step (b) of the method, and to discharge said portion of raw solution through said first brine discharge outlet in step (c) of the method.

21. The cleaning system of Claim 18, wherein said desalination plant is a multi-stage plant, said plurality of RO modules is a first stage thereof, and the desalination plant further comprises

e) a next-stage separator with a next-stage brine outlet and next-stage booster pump in communication with said next-stage brine outlet;

f) a common next-stage brine line connecting the permeate ports of said plurality of modules to said next-stage booster pump; and

g) suitable valves allowing using said next-stage brine as dilute saline solution at step (a) of the method of Claim 1 applied in turn to each module of said plurality of modules.

22. The cleaning system of Claim 21, wherein said next-stage separator has an inlet connected to said common permeate collection line, and is adapted to perform separation over the permeate from said first stage, thereby obtaining said next-stage brine.

23. The cleaning system of Claim 18, wherein each one of said plurality of modules has a front-end permeate port and a rear-end permeate port in communication with the permeate side of the RO membrane, said common permeate collection line being connected to said rear-end permeate port of each module, the system further comprising

g) a second source of second dilute saline solution;

h) a common line connecting said front-end permeate ports of said modules to said second source; and

i) a plurality of valves and pumps adapted to close or open each of the above ports and common lines and to feed each of said dilute saline solutions to a predetermined front-end or rear-end permeate port of each of said RO modules in predetermined order and under predetermined pressure.

24. The cleaning system of Claim 18, further comprising a tank with cleaning agent, a line connecting said tank to said source of dilute saline solution, and a feeding means adapted to feed said cleaning agent to said source of dilute saline solution.

25. The cleaning system of Claim 18, further comprising a tank with cleaning agent, a common line connecting said tank to said front-end feed ports of said modules or/and to said rear-end brine ports of said modules, and feeding means adapted to feed said cleaning agent to selected ones of said feed ports together with the concentrated saline solution during step (b) of the cleaning method.

26. The cleaning system of Claim 18, wherein said desalination plant includes an energy recovery plant connected to said first brine discharge outlet, said cleaning system further comprising a booster pump with inlet port connected to said second line and outlet port connected to said common brine collection line.

27. The cleaning system of Claim 18, wherein said pressurized source of dilute saline solution is a permeate storage tank.

28. The cleaning system of Claim 27, wherein said permeate storage tank is pressurized by means of a high-pressure feed pump.

29. The cleaning system of Claim 27, wherein said permeate storage tank is a pressure-exchange vessel having a permeate chamber and a feed chamber divided by a moveable impermeable wall, the permeate chamber being connected to said common high-pressure cleaning line, the feed chamber being connected via a first stop valve to a high-pressure fluid source and via a second stop valve to a discharge line, so that said vessel can be filled with high-pressure fluid to discharge the permeate under high pressure via said cleaning line, and can be filled with permeate to discharge said fluid through said discharge line.

30. The cleaning system of Claim 29, wherein said high-pressure fluid source is said common high-pressure raw solution feed line.

31. The cleaning system of Claim 29, wherein said high-pressure fluid source is said common high-pressure brine collecting line.

32. The cleaning system of Claim 29, wherein said moveable impermeable wall is a flexible diaphragm.

33. The cleaning system of Claim 29, wherein said moveable impermeable wall is a sliding sealed piston.

34. A method of cleaning a fouled RO membrane in a module for RO separation, said membrane having a feed side and an opposite permeate side and extending between a front end and a rear end of said module, said module having a front-end feed port and a rear-end brine port in communication with said feed side of the membrane, and at least one permeate port in communication with said permeate side of the membrane, a normal RO separation process in the same module including feeding raw saline solution, which comprises solvent, dissolved salts and a potential foulant with osmotic pressure PO1, to said front-end feed port at gauge pressure PF1 > PO1, collecting weak saline solution called permeate with osmotic pressure PO2 from said permeate port at gauge pressure PP2, and removing residual brine from said rear-end brine port, the foulant accumulating at the feed side of the RO membrane, wherein said cleaning method comprises

a) changing said gauge pressure PF1 to a pulsating gauge pressure PF1' with average value close to said osmotic pressure PO1 so that a net driving differential ΔPN resulting from pressures PO1, PO2, PP2, and PF1' would be directed alternatively to the feed side and the permeate side of the membrane, whereby, when said ΔPN is directed to said feed side, the solvent is being sucked from the permeate side of the RO membrane to the feed side of the RO membrane, penetrates into the interface between the membrane and the accumulated foulant, and separates the foulant from the membrane surface, while when said ΔPN is directed to said permeate side, the RO membrane performs normal RO separation; and

b) withdrawing the raw saline solution together with the separated foulant through said rear-end brine port.

35. The method of Claim 34, including

c) feeding the raw saline solution obtained in step (b) to an energy recovery plant.